DRINKING WATER OBJECTIVES

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EXPRESSION OF RESULTS

Milligrams per litre (mg/l) are employed in these objectives as it is considered that the slightly less exact expression "parts per million" (ppm) should be progressively abandoned. Whenever possible, chemical components should be expressed in ions. Turbidity should be expressed in units of turbidity, and color in units of color based upon the platinum-cobalt scale. Volumes should be expressed in millilitres (ml), and temperature should be measured in degrees Celsius (°C).

In bacteriological analysis, the total number of micro-organisms developing on solid media should be expressed in significant figures as colonies per 100 millilitres of sample liquid (water or waste water, etc.) and the medium, time, and temperature of incubation in degrees Centigrade (°C) with the quantity of material examined being stated. Coliform numbers should be given in terms of "Most Probable Number" per 100 ml (MPN/100 ml) or "Membrane Filter Count" per 100 ml (MFC/100 ml).

Health hazards are conditions, devices, or practices in the water-supply system and its operation that create, or may create, a danger to the health and well-being of the water consumer. An example of a health hazard is a structural defect in the water-supply system, whether of location, design or construction, which may regularly or occasionally prevent satisfactory purification of the water supply or cause it to be polluted from extraneous sources.

Pollution is defined as the presence of any foreign substance (organic, inorganic, radiological, or biological) in water that tends to degrade its quality so as to constitute a health hazard or impair the usefulness of the water.

A standard sample for bacteriological analysis shall consist of a minimum of 150 millilitres (ml) (approximately 6 ounces) of water collected in a glass container that has been sterilized by a recognized and tested laboratory procedure.

Water supply system includes the works and auxiliaries for collection, treatment, storage, and distribution of the water from the sources of supply to the free-flowing outlet of the ultimate consumer.

SOURCE AND PROTECTION

The water supply should be obtained from the most desirable source feasible, and effort should be made to prevent or control pollution of the source. If the source is not adequately protected by natural means, the supply shall be adequately protected by treatment.

Frequent sanitary surveys shall be made of the water-supply system to locate and identify health hazards which may exist in the system. The manner and frequency of making these surveys, and the rate at which discovered health hazards are to be removed, shall be in accordance with a program approved by the Ministry.

Approval of water supplies shall be dependent in part upon:

(a) Enforcement of requirements to prevent development of health hazards;

(b) Adequate protection of the water quality throughout all parts of the water-supply system, as demonstrated by frequent surveys;

(c) Proper operation of the water-supply system under the responsible charge of personnel whose qualifications are acceptable to the Ministry;

(d) Adequate capacity to meet peak demands without development of low pressures or other health hazards;

(e) Records of laboratory analyses showing consistent compliance with the water quality requirements of these objectives.

For the purpose of application of these objectives, responsibility for the conditions in the water-supply system shall be considered to be held by:

(a) The water purveyor, from the source of supply to the connection to the customer's service piping;

(b) The owner of the property served and the municipal or other authority having legal jurisdiction, from the point of connection to the customer's service piping to the free-flowing outlet of the ultimate consumer.

BACTERIOLOGICAL QUALITY

No bacteriological analysis of water, however exact, can take the place of a complete knowledge of the conditions at the sources of supply and throughout the distribution system. Every water supply should be regularly inspected from source to distribution taps, and sampling should be repeated under various seasonal conditions, especially after heavy rainfall. It should be emphasized that when sanitary inspection indicates a water, as distributed, to be subject to pollution, the water should be considered suspect irrespective of the results of bacteriological analyses of water leaving the treatment plant. Contamination is often intermittent and may not be revealed by the examination of a single sample. The analyses of a single sample can indicate no more than the conditions prevailing at the moment of sampling; a satisfactory result cannot guarantee that the observed conditions will persist in the future. The quality of a water supply can be assessed only by a series of samples over a period of time.

Sampling

Sterile bottles, six ounces (180 ml) or more containing sodium thiosulphate ($Na_2S_2O_3$), must be used to collect samples for submission to the Ministry laboratory for bacterial analysis. To ensure reliable results, samples should arrive at the testing laboratory within 24 hours of sampling or be refrigerated if delay is unavoidable. Samples collected in containers presumed unsterile; older than 72 hours; or held under unsatis-

PHYSICAL CHARACTERISTICS

Sampling

The minimum standards for frequency and manner of sampling shall be as determined by the Ministry of the Environment. Under normal circumstances, samples should be collected one or more times per week from representative points in the distribution system and examined for turbidity, color, threshold odor, and taste.

Limits

Drinking water should contain no impurity which would cause offence to the sense of sight, taste or smell. Under general use, the following limits should not be exceeded: turbidity, 1 unit; color, 5 units; and the threshold odor number, 3.

Analytical Methods

The methods used for determining the physical characteristics shall be as prescribed in the current edition of Standard Methods for the Examination of Water and Wastewater.

CHEMICAL CHARACTERISTICS

Sampling

The minimum standards for frequency and manner of sampling shall be as determined by the Ministry of the Environment. Under normal circumstances, analyses for substances listed below need be made only semi-annually. If however, there is some presumption of unfitness because of the presence of undesirable elements, compounds, or materials, periodic determinations for the suspected toxicant or material should be made more frequently, and an exhaustive sanitary survey should be made to determine the source of the pollution. Where the concentration of a substance is not expected to increase in processing and distribution, available and acceptable source-water analyses performed in accordance with standard methods may be used as evidence of compliance with these objectives.

Where experience, examination, and available evidence indicate that particular substances are consistently absent from a water supply or below levels of concern, semi-annual examinations for those substances may be omitted when approved by the Ministry.

Limits

Drinking water shall not contain impurities in concentrations that may be hazardous to the health of the consumers. It should not be excessively corrosive to the water-supply system. Substances used in its treatment shall not remain in the water in concentrations greater than required by good practice. Substances that may have deleterious physiological effect, or substances for which physiological effects are not known, shall

not be introduced into the system in a manner that would permit them to reach the consumer.

The chemical substances shown in Table 1 should not be present in a water supply in excess of the listed concentrations where, in the judgment of the Ministry, other more suitable supplies are or can be made available.

TABLE 1

Substance	Concentration mg/l
Alkyl benzene sulfonate (ABS)	0.5
Arsenic (As)	0.01
Chloride (Cl)	250.0
Copper (Cu)	1.0
Carbon chloroform extract (CCE)	0.2
Cyanide (CN)	0.01
Fluoride (F)	*
Iron (Fe)	0.3
Manganese (Mn)	0.05
Nitrate (N)**	10.0
Phenols	0.001
Sulfate (SO_4)	250.0
Total dissolved solids	500.00
Zinc (Zn)	5.0
Total Organic Carbon (C)	5.0
Organic Nitrogen (N) Total Kjeldahl minus free ammonia	0.15
Methane (Ground Waters Only)	50 cu ft/100,000 gal

* See section on Fluoride

** In areas in which the nitrate content of water is known to be in excess of the listed concentration, the public should be warned of the potential dangers of using the water for infant feeding.

The presence of substances in excess of the concentrations listed in Table 2 shall constitute grounds for rejection of the supply.

TABLE 2

Substance	Concentration mg/l
Arsenic (As)	0.05
Barium (Ba)	1.0
Cadmium (Cd)	0.01
Chromium (Cr^{6+})	0.05
Cyanide (CN)	0.2
Fluoride (F)	*
Lead (Pb)	0.05
Selenium (Se)	0.01
Silver (Ag)	0.05

* See section on Fluoride

Fluoride

When fluoride is naturally present in drinking water, the concentration should not average more than 1.2 mg/l. Presence of fluoride in concentrations more than 2.4 mg/l shall constitute grounds for rejection of the supply.

Where fluoridation (supplementation of fluoride in drinking water) is practised, the fluoride concentration recommended is 1 mg/l with a permissible operating range of 0.8 mg/l to 1.2 mg/l.

Fluoridated and defluoridated supplies shall be sampled with sufficient frequency to determine that the desired fluoride concentration is maintained.

Analytical Methods

The methods used for determining the chemical characteristics shall be as prescribed in the current edition of Standard Methods for the Examination of Water and Wastewater.

RADIOACTIVITY

Sampling

The frequency of sampling and analysis for radioactivity shall be determined by the Ministry of the Environment after consideration of the likelihood of significant amount being present. Where concentrations of Radium-226 (Ra226) and Strontium-90 (Sr90)

may vary considerably, quarterly samples composited over a period of three months are recommended. Samples for determination of gross activity should be taken and analyzed more frequently.

As indicated in "Chemical Characteristics", data from water analyses of available and acceptable sources may be used to indicate compliance with these requirements.

The effects of the exposure of humans to radiation is viewed as harmful, and any unnecessary exposure to ionizing radiation should be avoided. The concentrations of radioactivity specified in Table 3 for drinking water are intended to limit intake of the substances by this route, so that total radiation exposure of population groups does not exceed appropriate "Radiation Protection Guides" recommended by the United States Federal Radiation Council. Concentrations which exceed, on the average, the values presented in Table 3 for a period of one year shall constitute grounds for rejection of the supply. Where the total intake of Ra226 and Sr90 from all sources has been determined, the limits may be adjusted by the Ministry so that the total intake of Ra226 and Sr90 will not exceed 7.3 micro micro-curies (μμc) per day and 73 (μμc/day, respectively.

TABLE 3

Radionuclides	Concentration μμc 1
Radium-226 (Ra226)	3
Strontium-90 (Sr90)	10
Gross beta activity (Sr90 and alpha emitters absent*)	1,000

*Absent is taken here to mean a negligibly small fraction of the above specific limits, where the limit for unidentified alpha emitters is taken as the listed limit for Ra226.

When mixtures of Ra226, and Sr90, and other radionuclides are present, the above limiting values shall be modified to ensure that the combined intake is not likely to result in radiation exposure in excess of the Radiation Protection Guides recommended by the United States Federal Radiation Council.

LIMITS FOR DISTRIBUTION SYSTEMS

The Most Probable Number (MPN) method or the Membrane Filter (MF) method may be used to enumarate coliform bacteria for the purpose of assessing water quality as described in the limits below. In addition, limits are provided for other pollution indicator bacteria which may be determined by the MPN, MF or Presence-Absence (P-A) tests.

(1) Water used by a community for consumption and other domestic purposes should be piped and adequately treated to render it free from disease-producing organisms. It is reasonably certain that disease organisms are absent if no pollution indicator bacteria are found during examinations of 100 ml samples. Hazardous quality indicator organisms which include the fecal coliform and fecal streptococcus groups and pathogenic organisms such as *Pseudomonas aeruginosa* and *Staphylococcus aureus* should be completely absent from drinking water. It should also be relatively free from coliforms, *Aeromonas* bacteria and *Clostridium perfringens*, which indicate poor water quality or deteriorated conditions in the water treatment plant or distribution system.

(2) When a minimum of two distribution system samples of 100 ml are examined each week, no sample should show the presence of fecal coliforms or fecal streptococci, or pathogens, such as *Pseudomonas aeruginosa* and *Staphylococcus aureus*, or a density of five or more coliform bacteria per 100 ml. If any of these limits are exceeded, the following action should be taken:

(3) Immediate collection and analysis of special samples from the affected and adjacent locations should be initiated, together with an investigation by the operating authority of the cause of their presence. If the results of these special samples also exceed the limits in section (2), then the following further action should be taken:

(4) Immediate chlorination should take place to insure a total chlorine residual of 0.5 mg/l or a free chlorine residual of 0.2 mg/l at the end of the distribution system; and if circumstances warrant, the immediate issuance of a boil-water order should be made. Thorough resampling and analysis of the entire water system should immediately begin and continue until the limits described in section (2) are not exceeded.

(5) When coliform bacteria are present at levels below 5 per 100 ml, they should not be detected in more than 5% of the monthly samples, nor should such organisms as *Aeromonas* or *Clostridium perfringens* be detected in more than 10% of the monthly samples.

(6) If the limits in (5) are exceeded, an inspection of the water works and distribution system should take place along with sufficient special samples to determine the cause for the limits being exceeded and remedial action as in (3) should be taken if required. This action should continue until the limits are no longer exceeded.

(7) Special samples collected as the result of an adverse bacteriological sample shall be considered additional to the total number required to be collected by a municipality for assessment of its water quality.

factory storage conditions will be discarded and new samples requested.

Frequency of Sampling

The frequency of bacteriological analyses for the control of the sanitary quality of a water supply and the location of sampling points at pumping stations, treatment points, reservoirs, and booster pumping stations, as well as in the distribution system, should be such as to enable proper supervision of the bacteriological quality of the water supply to be maintained. The frequency of analyses and the location of sampling points shall be established by the Ministry after investigation of the source, method of treatment, and protection of the water concerned. The samples shall not necessarily be taken from the same point on each occasion. Only properly collected samples are suitable for analysis, and only these will be considered in determining the quality of a supply.

Plant Samples

In systems utilizing surface water or treated ground water, samples shall be taken and analyzed from the raw water source and the point at which treated water enters the distribution system with at least the same frequency as that for the distribution system. In addition, there should be several checks on the chemical disinfection process each day.

In systems utilizing untreated ground-water, samples shall be taken and examined not less than once per week from the source and all points at which water enters the distribution system.

Distribution System Samples (Piped Systems)

The minimum number of samples to be collected and the frequency of samples collection from a distribution system shall be determined from the following table.

Population Served	Minimum Number of Samples Per Month	Minimum Frequency Sampling
Up to 100,000	8 + 1 per 1,000 of population	Weekly
Over 100,000	100 + 1 per 10,000 of population	Daily

The number of samples determined with the use of the above table shall not include raw water or plant effluents whether treated or otherwise.

In determining the number of samples analyzed monthly, the following samples may be included, provided they have been analyzed by methods acceptable to the Ministry and the results are assembled and available for inspection by the Ministry.

(1) Samples analyzed by the Ministry laboratory.

(2) Samples analyzed by other government laboratories, either federal or provincial.

(3) Samples analyzed by water works authorities or by commercial laboratories, provided the analytical results are acceptable to the Ministry

. Adequate protection by treatment is any one or any combination of the controlled processes of coagulation, sedimentation, absorption, filtration, disinfection, or other processes that produce a water consistently meeting the requirements of these objectives. This protection requires processes that are appropriate to the source of supply; works that are of adequate capacity to meet maximum demands without creating health hazards, and that are located, designed, and constructed to eliminate or prevent pollution; and conscientious operation by well trained and competent personnel whose qualifications are commensurate with the responsibilities of the position and acceptable to the Ministry of the Environment.

DEFINITIONS

The coliform group of microorganisms includes all Gram negative, asporogenous, cytochrome oxidase negative, catalase positive, rod-shaped bacteria capable of growing in a bile salt medium and of fermenting lactose when incubated at 35-37°C within 48 hours. This group generally consists of the genera *Escherichia, Klebsiella, Enterobacter* and *Citrobacter.*

The fecal coliform group includes that portion of the coliform group which is capable of growth at 44-45°C within 24 hours. The genus most frequently associated with fecal pollution is *Escherichia* and to a lesser extent *Klebsiella* and *Enterobacter.*

The fecal streptococcus group comprises a number of species of the genus *Streptococcus* which by cultural and serological methods fall into the "Lancefield's Group D" category. These bacteria are Gram positive cocci, occurring in chains, catalase negative, and capable of growth at 45°C within 48 hours. Species of the genus *Streptococcus* commonly associated with fecal contamination include *S. faecalis, S. faecium, S. durans, S. bovis* and *S. equinus.*

Although pathogenic or potential disease-producing bacteria normally do not survive longer than the pollution indicator organisms described previously, two organisms occasionally isolated from distribution system samples are *Pseudomonas aeruginosa* and *Staphylococcus aureus. P. aeruginosa* is a Gram negative, cytochrome oxidase positive, rod-shaped bacterium. *S. aureus* is a Gram positive, catalase positive, coccus-shaped bacterium. Both of these organisms are found in sewage. They are potentially pathogenic and should be absent from domestic drinking water supplies.

Two other genera of bacteria frequently associated with inadequately treated water supplies are members of the genus *Aeromonas* and *Clostridium. Aeromonas* is a Gram negative, asporogenous, cytochrome oxidase positive, rod-shaped bacterium which frequently gives false positive coliform reactions. Its association with polluted water and sewage makes its presence in water supplies undesirable. *Clostridium perfringens* is an anaerobic, Gram positive, spore-forming, catalase negative, rod-shaped bacterium frequently associated with fecal material. Its survival after water treatment is an indication of marginal disinfection of the distribution water.

The microorganisms listed above are recovered by our current (1976) analytical test employing a variety of detection and identification procedures.

DRINKING WATER OBJECTIVES

INTRODUCTION

Water supplies for domestic purposes must be free from amounts of chemical substances and micro-organisms that would constitute a health hazard. Supplies of drinking water should not only be safe and free from dangers to health, but should also be as aesthetically attractive as possible. Absence of tubidity, color, and disagreeable or detectable tastes and odors is important in water supplies intended for domestic use. The location, construction, operation, and supervision of a water-supply system should exclude all potential sources of pollution and contamination.

In order to obtain drinking water having these desirable qualities, objectives regarding limits for certain sustances should be achieved. The objectives should be generally acceptable and should be applicable to all public water supplies in the Province of Ontario.

The following two types of limits should be recognized:

(a) Limits that, if exceeded, shall be grounds for rejection of the supply. Substances in this category may have adverse effects on health when present in concentrations above the limit.

(b) Limits that should not be exceeded whenever more suitable supplies are, or can be made, available at a reasonable cost. Substances in this category, when present in concentrations above the limit, are either objectionable to an appreciable number of people or exceed the levels required by good water quality control practices. These limits should apply to the water at the free flowing outlet of the ultimate consumer.

The limits presented are an effort to derive conservative values from the best information now available and may be adjusted as new and better data become available.

DEFINITION OF TERMS

The terms used in these objectives are as follows:

Adequate protection by natural means involves one or more of the following processes of nature that produce water consistently meeting the requirements of these objectives: dilution, storage, sedimentation, sunlight, aeration, and the associated physical and biological processes which tend to accomplish natural purification in surface waters and, in the case of groundwaters, the natural purification of water by infiltration through soil and percolation through underlying material and storage below the water table.